Responsiveness Summary for Agency Comments on Community Human Health Risk Assessment, Herculaneum, Missouri

EPA Comment	Doe Run Response
EPA Comments on 2006 Draft	
3. Section 3.1 (p. 13) We could not locate the additional text in this section nor does the discussion reference the appropriate section regarding data usability. Doe Run should provide additional details for each study where soil samples were collected (*e.g.*, how the samples were collected, sieve size, *etc.*) and reference Section 2.5 in the last sentence of each paragraph.	Section 2.1.1 references the data useability section (Section 2.5) in the last sentence of each paragraph. We are unable to provide additional details for each soil sampling study, as they are simply not available. All available information concerning sampling has been presented in the report.
4. Section 3.1.2 (p. 15) Region 7 does not agree that the regression equation demonstrates the XRF and laboratory results are comparable across the concentration range evaluated. The entire regression equation must be considered, not just the slope of the regression line. The large y-intercept term means there is a significant difference between XRF and laboratory results at low soil concentrations. For example, the equation predicts that a soil concentration of 300 mg/kg measured *via* XRF equals a laboratory concentration of 407 mg/kg. Doe Run should revise the text to acknowledge this discrepancy and/or conduct another regression analysis at soil concentrations where cleanup decisions may be impacted (*e.g.*, < 1,200 mg/kg). We do agree that the regression equation does not significantly impact the conclusions of the HHRA. However, this potential error does impact the implementation of soil cleanup goals and Region 7 will address this issue during the derivation of final cleanup goals.	Section 2.1.2 now includes the results of regression analyses for all data, data ≤1200 mg/kg, data ≤2000 mg/kg, and data >2000 mg/kg. We concluded that the XRF data do not need to be adjusted.
24. Section 8.2 (p. 51) The additional text in the first paragraph does not actually discuss any key findings from the lead criteria document (CD). Rather, it just reiterates the language provided in EPA's comment regarding the variety of adverse effects associated with lead exposure. Doe Run also did not make changes to the sections discussing effects on pregnancy and fetal development or effects on heme synthesis. At a minimum, Doe Run must replace Sections 4.2.2 and 4.2.3 with the following text. **4.2.2 Effects on Pregnancy and Fetal Development** Studies in animals reveal that relatively high blood levels during pregnancy can cause fetotoxic effect (spontaneous abortion and fetal death). Laboratory animal studies also provide unequivocal evidence that lead exposure results in a variety of sublethal effects on reproduction and development, including changes in levels or function of reproductive hormones, adverse effects on the gonads (both male and female) and conception (EPA, 2006). In terms of human exposure, it is clear that lead crosses the placenta	The detailed discussion on the adverse effects of lead was moved from Section 4.2 to a new appendix, Appendix H. EPA's required text from this comment was added to Sections H.2 and H.3.

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during pregnancy and exposure to the mother results in fetal exposure (EPA, 2006). Some epidemiologic studies in humans have detected a small association between elevated blood lead levels and endpoints such as decreased fetal size or weight, shortened gestation period, decreased birth weight, congenital abnormalities, spontaneous abortion and still birth (ATSDR, 2005a and EPA, 1986, 2006). However, these effects are not detected consistently in different studies, and some researchers have detected no significant association between blood lead levels and signs of fetotoxicity. While some studies provide suggestive evidence that blood lead levels in the range of 10-15 µg/dL may cause small increases in undesirable prenatal as well as postnatal effects, the evidence is not definitive. **Section 4.2.3 Effects on Heme Synthesis** A characteristic effect of chronic lead exposure is anemia stemming from lead-induced inhibition of heme synthesis and a decrease in red blood cell life span. Lead interferes with heme synthesis by inhibiting the enzymes ALA-D or ferrochelatase (USEPA, 2006). Decreases in ALA-D activity can be detected at blood lead levels below 10 µg/dL in children and adults (ACGIH, 1995, EPA, 2006). At blood lead concentrations of 20-30 µg/dL, erythrocyte ALA-D activity is halved and ferrochelatase is significantly inhibited (EPA, 2006). It should be noted, however, that lead-induced anemia does not occur until blood lead levels in children and adults exceed 40 µg/dL and 50 µg/dL, respectively (ATSDR, 2005a, EPA 2006). Heme synthesis is inhibited not only in red blood cells but in other tissues. Several key enzymes that contain heme, including those needed to form vitamin D, also showed decreased activity following lead exposure (EPA, 1986). The CDC (1991) reviewed studies on the synthesis of an active metabolite of vitamin D and found that impairment was detectable at blood lead levels of 10-15 µg/dL.	
25. Section 8.2.1 (p. 51) Doe Run added one sentence to the end of this section that references the lead criteria for additional information on neurological effects in young children. This response does not adequately address Region 7's comment. Thus, Doe Run must replace the text in Section 4.2.1 with the following: The effect of lead usually considered to be of greatest concern in children is impairment of the nervous system. Many studies show that animals and humans are most sensitive to the effects of lead during nervous system development, and thus the fetus, infants, and young children (0-6 years of age) are particularly vulnerable. The effects of chronic low-level exposure on the nervous system are subtle, and normally cannot be detected in individuals, but only in studies of groups of children. Common measurement endpoints include various types of tests of	The detailed discussion on the adverse effects of lead was moved from Section 4.2 to a new appendix, Appendix H. EPA's required text in this comment was added to Section H.1 in Appendix H.

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intelligence, attention span, hand-eye coordination, *etc.* EPA's lead air quality criteria document (CD) provides a detailed summary of the current state of the science related to the neurological effects in young children (EPA, 2006). The CD concludes "Neurobehavioral effects of Pb-exposure early in development (during fetal, neonatal, and later postnatal periods) in young infants and children (≤ 7 years old) have been observed with remarkable consistency across numerous studies involving varying study designs, different developmental assessment protocols, and diverse populations. Negative Pb impacts on neurocognitive ability and other neurobehavioral outcomes are robust in most recent studies even after adjustment for numerous potentially confounding factors (including quality of care giving, parental intelligence, and socioeconomic status). These effects generally appear to persist into adolescence and young adulthood." A key finding from EPA (2006) is that "The overall weight of the available evidence provides clear substantiation of neurocognitive decrements being associated in young children with blood-Pb concentrations in the range of 5-10 µg/dL, and possibly somewhat lower." In other words, the studies evaluated in the criteria document consistently show that exposure to lead affects the intellectual attainment and academic performance of preschool and school age children at blood lead levels in the 5 to 10 µg/dL range, while evidence supporting neurological effects below 5 µg/dL is less definitive. Furthermore, EPA's final Staff Paper for Lead NAAQS (EPA, 2007d) states "In particular, we note that currently available studies provided evidence of adverse health effects associated with blood lead levels and environmental exposures well below those previously identified, and that there is now no discernible threshold for such effects in contrast to the thresholds that had previously been inferred." "In particular, there is now no recognized safe level of Pb in children's blood and studies appear to show adverse effects at mean concurrent blood Pb levels as low as 2 µg/dL." These conclusions are supported by the Clean Air Scientific Advisory Committee's (CASAC) review of the CD and Staff Paper (Henderson, 2007), which states "Moreover, there is no evidence of a threshold for the adverse consequences of lead exposure; studies show that the decrements in intellectual (cognitive) functions in children are proportionately greater at Pb concentrations < 10 µg/dL..." "In fact, this evidence suggests these blood lead concentrations below 5 µg/dL are associated with unacceptable adverse effects." Last of all, the Centers for Disease Control's Advisory	

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Committee on Childhood Lead Poisoning Prevention recently issued a report stating that "Research conducted since 1991 has strengthened the evidence that children's physical and mental development can be affected at BLLs < 10 µg/dL (CDC, 2007)."	
27. Section 8.2.5 (p. 53) The additional text does not adequately address EPA's comment. In the first paragraph, Doe Run's only additional text (in bold and underlined) was to revise the second sentence from "beginning at around 10 µg/dL or..." to "...beginning at around **5**-10 µg/dL or..." This section continues to cite the 1986 lead criteria document and does not discuss the most recent science from the 2006 criteria document nor does it mention the CDC's position that adverse health effects occur at blood levels less than 10 µg/dL. The text added to the end of the second paragraph only references the Lead NAAQS. It does not summarize EPA's conclusions that adverse neurological effects occur in young children at blood lead levels below 10 µg/dL. The second paragraph also misrepresents CDC's current position regarding blood lead levels in young children because it appears to imply that CDC is not concerned with about adverse health effects at blood lead levels below 10 µg/dL. The text fails to mention that even though CDC has concluded there is evidence of adverse health effects in children with blood lead levels below 10 µg/dL, CDC has not changed its level of concern, in part, because they "...believe it critical to focus available resources where the potential adverse effects remain the greatest (CDC, 2005)." Because Doe Run's response does not adequately address Region 7's comment, Doe Run must replace the text in Section 4.2.5 with the following: It is currently difficult to identify what degree of lead exposure, if any, can be considered safe for infants and children. As discussed above, US EPA has concluded that the overall weight-of-evidence provides clear substantiation of lead-induced neurological effects in children at blood lead levels in the range of 5-10 µg/dL or possibly lower (EPA, 2006, 2007a). Moreover, CDC (2007) indicates the evidence has strengthened that physical and mental development in children can be affected at blood lead levels below 10 µg/dL. There is also evidence of adverse health effects in adults at blood lead level concentrations below 10 µg/dL (EPA, 2006). Of special concern is the fact that numerous scientists have concluded the effects of lead on neurological performance, heme synthesis, and fetal development may not have a threshold value, and that the effects are long-lasting (ATSDR, 2005a; Henderson, 2007; EPA, 1986, 2006, 2007d). On the other hand, some researchers and clinicians believe the effects that occur in	The detailed discussion on the adverse effects of lead was moved from Section 4.2 to a new appendix, Appendix H. EPA's required text in this comment was added to Section H.5 in Appendix H.

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children at low blood lead levels are so minor that they need not be cause for concern (ATSDR, 2005a). EPA has established a health protection goal of limiting exposure to soil lead levels such that there should be no more than a 5% probability that a residential child (< 7 years old) will have a blood lead level above 10 µg/dL (EPA, 1994c, 1998a). The bases for this goal are analyses conducted by EPA and CDC documenting adverse health effects associated with childhood lead exposure at or below a blood lead level concentration of 10 µg/dL (EPA, 1986, 1990; CDC, 1991). EPA is currently reviewing its health protection goal because there is overwhelming evidence that neurological effects occur at blood lead levels well below 10 µg/dL.	
29. Section 9.2.3 (p. 57) Re: Cadmium and arsenic in homegrown produce. The HHRA should clarify the rationale Doe Run used to determine the data are not adequate for risk assessment purposes.	The rationale for not including risk calculations for ingestion of homegrown produce was added to the end of Section 5.2.3.
32. Section 10.9.1 (p. 66) The revised HHRA now indicates that "US EPA guidance states that such comparisons between predicted and observed data are appropriate (U.S. EPA, 1998a; 1994b)." Both documents do indicate that data from "well-designed blood lead studies" can provide useful information in making a risk management decision. In addition, EPA (1994) and Hogan, *et al.* (1998) outline several criteria that must be satisfied before blood lead data can be used for comparison to IEUBK model blood lead predictions. The screening program conducted in 2001 by MDHSS and ATSDR clearly does not satisfy these criteria nor does it constitute a "well-designed blood lead study." As a result, the empirical comparison is fundamentally flawed and invalid. To reiterate our previous comment, Doe Run must revise the HHRA to indicate that the data are not adequate to perform an empirical comparison and delete all remaining text which discusses this issue. The text must also state that these data demonstrate that blood lead levels have declined since 1975 and this decline is likely due to a variety of factors, including decreases in airborne smelter emissions, residential yard cleanups, and health education. Last of all, Doe Run must revise the heading of Section 6.9 to "Summary of Blood Lead Data."	The Section 6.9 heading was changed to "Summary of Blood Lead Data." The text now states that these data demonstrate that blood lead levels have declined since 1975; this decline is consistent with a national decline in blood lead levels during this same time period, and is likely due to a variety of both national and local factors. Local factors that likely contributed to the decline include decreases in airborne smelter emissions, residential yard cleanups, and health education. The text describing the comparison of observed and predicted blood lead levels has been removed from the Risk Assessment. However, see further discussion about this comment in the Cover Letter that accompanies the Risk Assessment. We did not add the statement that "the data are not adequate to perform an empirical comparison", because all mention of performing a comparison was removed from the report text.
33. Section 10.9.2 (p. 67) The text was revised to indicate there are several uncertainties associated with comparing observed and predicted blood lead levels. Once again, this empirical comparison is fundamentally flawed and invalid because the MDHSS/ATSDR screening program is not appropriate for making such comparisons. In addition, the exposure conditions of the adult resident population do not match those assumed in the Adult Lead Methodology (ALM), which is relevant for commercial/industrial	The text describing the comparison of observed and predicted blood lead levels was removed from Section 6.9.2. However, see further discussion about this comment in the Cover Letter that accompanies the Risk Assessment. A statement was added to Section 6.9.2 to indicate that these blood lead data demonstrate that some adolescents and adults have been impacted by lead from the

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workers. As requested previously by Region 7, Doe Run must delete all text discussing the comparison of observed and predicted blood lead levels in adolescents and adults. Doe Run must also revise the text to indicate that these blood lead data demonstrate that adolescents and adults have been impacted by lead from the Herculaneum smelter.	Herculaneum smelter.
35. Section 11.2 (p. 70) As discussed previously by Region 7, site-specific data are not available to derive naturally-occurring background levels for chemicals of potential concern. Therefore, the text should only present the clean-up goals for arsenic based on cancer and non-cancer health effects. Region 7 will take available background data into account when selecting a final clean-up goal for the site, which may be less than the non-cancer RBC of 27 mg/kg. Doe Run must delete the text on the first paragraph of page K-3 beginning with "These concentrations..." and ending with "...considered acceptable by US EPA." Doe Run must also delete the text in the next two paragraphs referring to the number of properties with arsenic exceeding the RBC of 27 mg/kg.	Per EPA's instructions the required text was deleted from Appendix K. However this revision does not improve the risk assessment. Note that the discussion that EPA asked to be removed, that the arsenic cancer-based RBC concentrations between 0.4 and 4.8 mg/kg are consistent with natural background, is not based on a determination of local natural background. Natural background levels world wide are in this range, or higher. No determination of local background will change this conclusion.
38. Section 12.2.2 (p. 79) Doe Run should provide the entire regression equation for the fine *versus* total soil fractions in Table 31, which is referenced in this section. While the slope of the regression line is important, the y-intercept term must also be considered when interpreting the results.	The entire regression equation was added to Section 7.2.2.
45. Section 12.2.7 (p. 87) After further consideration, EPA has determined that the discussion of the recontamination data is not relevant to the HHRA. Therefore, Doe Run should delete Appendix J and Section 7.2.7 from the HHRA.	Per EPA's instructions, Appendix J and Section 7.2.7 were removed from the HHRA.
47. Section 13 (p. 90) A soil concentration of 400 mg/kg is EPA's screening level for lead, not the Agency's health protection goal. Doe Run should revise the text and Table 34 to provide the percentage of residential properties where the probability of exceeding a blood lead level of 10 µg/dL is greater than 5%.	The text in Section 8 was revised to present the percentage of residential properties in each exposure area that exceed EPA's health protection goal of 5% for the probability of exceeding a blood lead level of 10 µg/dL.
48. Section 13 (p. 91) As discussed in our response to Comment 32 and 33, no conclusions can be made because the comparison of predicted and observed blood lead levels is fundamentally flawed and invalid. Thus, Doe Run must delete the second paragraph on page 96 which summarizes the empirical comparisons.	Per EPA's instructions this paragraph was deleted from Section 8.
56. Appendix D (Tables 4.1 and 4.2) The reference was not revised in the footnotes of several tables, including Tables 4.1, 4.2, 6.1, and the Dermal Worksheet.	In Appendix D, the footnotes were revised for Tables 4.1, 4.2, 6.1, and the Dermal Worksheet.

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1. Section 2.3.1 (p. 10) We do not agree that arsenic, cadmium, and nickel should be excluded as COPCs due to low detection frequency and low airborne concentrations. Region 7 does not exclude site-related contaminants based on frequency of detection, unless contaminants have not been detected in all samples. More importantly, the detected concentrations of these three contaminants significantly exceed (>100-fold) the residential air screening levels. In addition, U.S. EPA no longer recommends substituting ½ the limit of detection for non-detects or censored data. Rather, ProUCL 4.0 should be used to calculate the upper confidence limit of the arithmetic mean for left censored data sets (see http://www.epa.gov/esdltsc/software.htm). Doe Run should delete the last sentence of the first paragraph because the selection of the COPC discussion is not relevant in this section. The text in Section 2.6 (p. 17), which refers to COPCs in air, should be revised to indicate that the air concentrations of arsenic, cadmium, and nickel exceed the residential air concentrations, however, the EPA data are not representative of current exposure conditions nor are the data appropriate for quantifying chronic inhalation exposure (*i.e.*, data usability). Thus, the HHRA will not quantify the potential health risks from inhalation exposure to particulates containing arsenic, cadmium and nickel. The uncertainty section should also indicate that the health risks are likely underestimated because the air pathway was not quantified.	Per EPA's instructions the required text was deleted from Section 2.3.1. The text in Section 2.6 was revised to indicate that the that the air concentrations of arsenic, cadmium, and nickel exceed the residential air concentrations, however, the EPA data are not representative of current exposure conditions, and the data are not appropriate for quantifying chronic inhalation exposure. Therefore, the HHRA did not quantify potential health risks from inhalation of particulates containing arsenic, cadmium , and nickel. A statement was added to Section 7.1.6 in the uncertainty section, to indicate that health risks are likely underestimated because the air pathway was not quantified.
2. Section 5.1.2 (p. 60) This section should be revised to state that the cancer risks based on the maximum concentration as the EPC slightly exceeded 1E-04 for the long term resident in EAs 2A and 2B and the trespasser in EA 13.	The statement was added to the text. We noted that these exceedances are viewed as slight because risks are typically rounded to one significant digit, in which case risks would fall within EPA's acceptable range.
3. Section 6.2 (p. 65) In the last sentence of the second paragraph, there is a typographical error in that "EA 22A" and "EA 22B" should be "EA 2A" and "EA 2B", respectively.	The text was revised.
4. Section 6.4 (p. 66) As pointed out by MDHSS, the time-weighted concentrations were incorrectly calculated. EPA's "Assessing Intermittent or Variable Exposures at Lead Sites" indicated that time-weighting should be based on the smallest time period in which the exposures repeat (the exposure event period). In this case, the time-weighting should be 5 days/7 days for exposure at school, not 180 days/365 days. This error results in a slight underestimate of the exposure point concentrations for the High School and Taylor School, while EPC is overestimated for the Middle School. Doe Run should revise the lead risk estimates and clean-up goals using the correct time-weighted procedure for these three exposure areas.	The lead risks were recalculated using 5 days/7 days for the High School, Middle School, and Taylor School. The cleanup goals in Table K.3 were not revised, as they are based on 5 days/week in school. The 5 days/week line in Figure K2 shows the RBC based on 5 days at school and 2 days at home.

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5. Section 8 (p. 94) The second paragraph should also state that the excess lifetime cancer risks based on the maximum concentration as the EPC range from 4E-07 to slightly greater than 1E-04.	The text was revised.
6. Appendix C Doe Run should revise Table 2.2 to reflect the EPA high-volume air monitoring results discussed in Section 2.3.1. For screening purposes, the maximum concentrations should be compared to the residential air screening levels, as discussed in Comment 1.	Table 2.2 in Appendix C was revised to show the maximum high-volume air monitoring results compared to residential air screening levels. We determined that the EPA monitors were in EA-1A and EA-2A. The table footnote states that these data were not used in the HHRA because the data are not representative of current conditions.
7. Appendix D Figures 2 and 3 are referenced on page D-6, but are missing from the Appendix.	The figures were added to Appendix D.

Response to MNDR and MDHSS Comments (5/28/09)
on Community Human Health Risk Assessment, Herculaneum, Missouri

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11. Schools MDHSS previously commented that the time-weighted average concentrations used as the exposure point concentrations (EPCs) to evaluate risk for school children were calculated incorrectly. Gradient responded that the calculation is correct and is based on assuming 185 days at school and 180 days at home. The time-weighting procedures provided in EPA's *Assessing Intermittent or Variable Exposures at Lead Sites* demonstrate that calculations should be based on the smallest time period in which the exposures repeat; therefore, the time-weighted averages for school child exposures should be based on 5 days at school and 2 days at home. The document should be modified using the correct time-weighting procedure.	The lead risks were recalculated using 5 days/7 days for the High School, Middle School, and Taylor School.
12 and 13. Comparison of Observed and Predicted Blood Lead Levels MDHSS previously commented that the document incorrectly references a 2001 blood lead "study" conducted by MDHSS/ATSDR and that instances referring to a "study" be revised. Gradient replied that the text was revised; however, the document still incorrectly references this as a "study." MDHSS reiterates that a "study" has not been conducted for Herculaneum, the testing conducted was simply a screening offered to the community as an intervention effort. Again, any instances referring to "study" must be revised. In addition, MDHSS also provided the following comment regarding comparison of observed and predicted blood lead levels: *MDHSS believes it is inappropriate to draw conclusions that the IEUBK and ALM models are overpredicting environmental lead risks based on the comparison presented. It is unreasonable to assume that a comparison based on such broad geographic area is adequate for such conclusions. Additionally, both model predictions and measured observations contain a number of limitations that are not discussed to qualify the differences noted. For instance: risk assessment is not an exact science, results are probabilities not certainties, and model predictions are based on hypothetical receptors employing a number of assumptions, and therefore, cannot be expected to directly correspond to observed results; the blood lead testing conducted was voluntary and not necessarily a representative sampling of the community; and no mention is made of the potential impact from community awareness and intervention efforts on the observed blood lead levels. MDHSS recommends that either observed results simply be presented in the assessment with no comparison made*	Per MDHSS and EPA's instructions the text describing the comparison of observed and predicted blood lead levels has been removed from the Risk Assessment. However, see further discussion about this comment in the Cover Letter that accompanies the Risk Assessment.

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to predicted results or the comparison be revised to include information to qualify the noted differences, and the stated conclusions based on this comparison be stricken from the assessment. Subsequent to our comment, EPA commented (EPA Comments 32, 33, and 48) that it is inappropriate to conduct an empirical comparison on a broad geographic basis and requested that the risk assessment indicate that the data are not adequate to perform an empirical comparison and all remaining text which discusses the issue be deleted. EPA also requested that the section indicate that the blood lead data demonstrate that the community has been impacted by lead from the Herculaneum smelter, but that blood lead levels have declined over time from a variety of factors including decreases in airborne smelter emissions, residential yard cleanups, and health education. Instead, Gradient's reply to these comments was to retain the comparison and to include caveats about the comparison as suggested by MDHSS. While caveats were added to the discussion, the text simply reiterates what was provided by in MDHSS' comment noted above. Furthermore, the conclusions based on the comparison were not stricken from the document as MDHSS previously recommended. Gradient's reply did not satisfy MDHSS' or EPA's concerns. Given our concerns and considering points made by EPA, MDHSS fully concurs and expects EPA's requested revisions to be made in the document.	